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[TITLE OF INVENTION IN KOREAN] 반사투과형 액정표시장치 및 그 제조방법

[TITLE OF INVENTION IN ENGLISH] Transflective liquid crystal display device and fabrication method of the same

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[EXAMINATION REQUEST] Request

[PURPORT] We submit application under the article 42 of the Patent Law and request examination of application under the article 60 of the Patent Law.

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[FEES]

[BASIC APPLICATION FEE]	20 pages	29,000	Won
[ADDITIONAL APPLICATION FEE]	25 pages	25,000	Won
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[ENCLOSED] 1. Abstract, Specifications (with Drawings) – 1 set

[DOCUMENT OF ABSTRACT]

[ABSTRACT]

The present invention relates to a transflective liquid crystal display device, and more particularly, to a transflective liquid crystal display device having a dual cell gap, a reflective plate of an uneven structure and a through hole and fabrication method of the same.

A transflective liquid crystal display device is directed to a structure having a dual cell gap, an uneven reflective plate and a through hole to meet customer's demand for high quality. Therefore, a liquid crystal display device is fabricated by forming a dual cell gap and an uneven reflective plate. However, many difficulties in design and process is accompanied in formation of a dual cell gap and an unevenness on an array substrate, also, relates to inferiority ratio of products, and thus becomes a minus cause in production of products.

As the present invention suggests a transflective liquid crystal display device structure that a step of a reflective portion and a transmissive portion for forming a cell gap is formed in a color filter substrate, processes concentrated on an array substrate are distributed, and thus a transflective liquid crystal display device insuring stability in design and process and having high quality of excellent cell efficiency, color property and brightness

[REPRESENTATIVE FIGURE]

FIG. 5

[INDEX WORD]

reflective plate of an uneven structure, dual cell gap, transflective, through hole, overcoat layer having a step

[SPECIFICATIONS]

[NAME OF INVENTION]

Transflective liquid crystal display device and fabrication method of the same

[BRIEF EXPLANATION OF FIGURES]

FIG. 1 is a cross-sectional view of a prior conventional transflective liquid crystal display device.

FIG. 2 is a cross-sectional view of a prior liquid crystal display device having a dual cell gap.

FIG. 3 is a cross-sectional view of a prior transflective liquid crystal display device having a through hole, a dual cell gap and a uneven reflective plate.

FIG. 4 is a plan view of a part of a transflective liquid crystal display device according to an embodiment of the present invention.

FIG. 5 is a cross-sectional view of a transflective liquid crystal display device according to a first embodiment of the present invention cut along a line A-A of FIG. 4.

FIG. 6 is a cross-sectional view of a transflective liquid crystal display device according to a second embodiment of the present invention cut along a line A-A of FIG. 4.

FIG. 7a to 7g are cross-sectional views of a fabrication method of an array substrate for a transflective liquid crystal display device according to a first embodiment of the present invention.

FIG. 8a to 8e are cross-sectional views of a fabrication method of an array substrate for a transflective liquid crystal display device according to a second embodiment of the present invention.

FIG. 9a to 9d are cross-sectional views of a fabrication method of a color filter substrate for a transflective liquid crystal display device according to a first embodiment of the present invention.

* Explanation of major parts in the figures *

100 : array substrate

101, 107 : transparent substrate

106 : gate electrode

110 : gate insulating film

113 : active layer

116a, 116b : ohmic contact layer

123 : source electrode

126 : drain electrode

130(130a, 130b) : first passivation layer

132 : organic film seed

140 : reflective plate of an uneven structure

45 : second passivation layer

150 : pixel electrode

55 : drain contact hole

160 : liquid crystal layer

70 : color filter substrate

175 : black matrix

80a, 180b, 180c : red, green and blue color filters

185 : overcoat layer

190 : common electrode

d_5, d_6 : cell gaps of transmissive and reflective portions

RA : reflective portion

SP : pixel

TA : transmissive portion

TH : through hole

Tr : thin film transistor

[DETAILED DESCRIPTION OF INVENTION]

[OBJECT OF INVENTION]

[TECHNICAL FIELD OF THE INVENTION AND PRIOR ART OF THE FIELD]

The present invention relates to a liquid crystal display device, and more particularly, to a fabrication of a color filter substrate for a transflective liquid crystal display device.

Recently, as the times have been advanced rapidly to information society, necessity of flat panel display devices having excellent properties of thin profile, low weight, low power consumption and the like has risen.

These flat panel display devices may be classified according to their ability for self-emission or not, and a flat panel display device self-emitting light and displaying images is referred to as a self-emissive display device and a flat panel display device using an external light source and displaying images is referred to as a non-emissive display device. Plasma display panel devices, field emission display devices, electroluminescent display devices and the like are used as emissive display devices, and liquid crystal display devices are used as non-emissive display devices.

Among these, liquid crystal display devices have been widely used for notebook and desktop monitors because of their excellent resolution, color display, quality of display image and the like.

In general, the liquid crystal display device is a display device displaying images, by arranging two substrates having electrodes such that surfaces where the two electrodes face each other, injecting a liquid crystal between the two substrates, moving liquid crystal molecules due to electric field generated by applying the two electrodes with voltages, and changing transmittance of light.

However, since the liquid crystal display device does not self-emit light, as explained above, it needs a separate light source.

Therefore, a backlight unit is disposed at a back surface of a liquid crystal panel, light emitted from the backlight unit is irradiated to the liquid crystal panel, and thus amount of light is adjusted according to alignment of liquid crystal, thereby displaying images.

This liquid crystal display device is referred to as a transmission type liquid crystal display device, and even though the transmission type liquid crystal display device displays bright images under dark external surroundings due to an artificial backlight source such as a backlight unit, it has a disadvantage that power consumption is high due to the backlight unit.

To supplement this disadvantage, a reflection type liquid crystal display device is suggested. The reflection type liquid crystal display device reflects an external natural or artificial light and adjusts transmittance of light according to alignment of liquid crystal, and its power consumption is smaller than that of the transmission type LCD device. In this reflection type liquid crystal display device, a pixel electrode formed on a lower array substrate is formed of a conductive material having a good reflectance, and a common electrode formed on an upper color filter substrate is formed of a transparent conductive material to transmit an external light.

However, the reflection type liquid crystal display device has an advantage of decreasing power consumption, whereas it has a disadvantage that it can not be used as a display device because brightness decreases if an external light is not sufficient.

Therefore, to overcome the above problem, a transflective liquid crystal display device is developed. The transmission type liquid crystal display device supplements a disadvantage that the reflection type liquid crystal display device can not be used as a display device because brightness decreases if an external light is not sufficient and a disadvantage that power consumption of the transmission liquid crystal display device is high so that it is a

product selectively using a transmissive mode using light of the backlight and a reflective mode using an external light.

As FIGs. 1 and 2 are cross-sectional views of a conventional transflective liquid crystal display device, FIG. 1 is a cross-sectional view of a transflective liquid crystal display device having a single cell gap and FIG. 2 is a cross-sectional view of a transflective liquid crystal display device having a dual cell gap.

As shown in FIG. 1, as shown, in a lower substrate 6, a gate electrode 6 is formed on a transparent substrate 2 and a gate insulating film 10 is formed thereon. A gate line (not shown) connected to the gate electrode 6 is further formed below the gate insulating film 10. Then, an active layer 13 and an ohmic contact layer 16a and 16b are sequentially formed on the gate insulating film 10 over the gate electrode 6. Source and drain electrodes 23 and 26 are formed on the ohmic contact layer 16a and 16b, and the source and drain electrodes 23 and 26 constitute a thin film transistor Tr with the gate electrode 6.

Meanwhile, a data line 20 of the same material as the source and drain electrodes 23 and 26 is formed on the gate insulating film 10, and even though not shown in the drawings, the data line 20 is connected to the source electrode 23. Also, the data line 20 crosses the gate line (not shown) to define a pixel SP.

Next, a first passivation layer 30 of an organic material having a low dielectric constant is formed on the thin film transistor Tr. A reflective plate 40 of a metallic material having a good reflectance is formed in a reflective region RA on the first passivation layer, a second passivation layer 45 of an inorganic material is formed on the reflective plate, and a pixel electrode 50 contacting the drain electrode 26 of the thin film transistor Tr through a contact hole 55 is formed in each pixel SP on the second passivation layer 45.

Meanwhile, in an upper substrate 70, a black matrix 75 is formed on an inner surface of a transparent substrate 71, and a color filter 80a, 80b and 80c where red (R), green (G) and blue (B) colors are sequentially repeated is formed below the black matrix, and an overcoat layer 85 and a common electrode 90 of a transparent conductive material are sequentially formed below the color filter 80a, 80b and 80c. Here, the color filter 80a, 80b and 80c is formed such that one color thereof corresponds to one pixel electrode 50, and the black matrix 75 partially overlaps edge of the pixel electrode 50 and corresponds to the data line 20.

Next, a liquid crystal layer 60 is formed between the pixel electrode 50 and the common electrode 90, and when a voltage is applied to the pixel electrode 50 and the common electrode 90, arrangement state of liquid crystal molecules in the liquid crystal layer 60 changes by an electric field generated between the two electrodes 50 and 90. At this time, even though not shown, respective orientation films are formed on the pixel electrode 50 and below the common electrode 90 to determine an initial arrangement state of the liquid crystal molecules.

Next, respective retardation films 95 and 97 are formed on outer surfaces of the lower and upper substrates 1 and 70 to adjust phase of light.

In the above-explained transflective liquid crystal display device, a cell gap d_1 of the reflective portion RA and a cell gap d_2 of the transmissive portion TA have the nearly same thickness. Accordingly, cell efficiency of the reflective portion RA or the transmissive portion TA is not optimized, and thus problems of reduction of transmittance and brightness and the like are generated.

A thing resolving above problems is a transflective liquid crystal display device having a dual cell gap as shown in FIG. 2. Explanations to the same parts as parts of the transflective liquid crystal display device as shown in FIG. 1 are omitted.

As shown, in a transmissive portion TA of a lower substrate 1, a first passivation layer 30 is removed, and thus a cell gap d_4 of the transmissive portion TA is double a cell gap d_3 of the reflective portion RA. The liquid crystal display device having a structure like FIG. 2 is transformed from a cell mode into an electrically controlled birefringence (ECB) mode, and since a transmittance curve is repeated periodically by double gaps on characteristic of the ECB mode, cell efficiency in the transmissive portion TA is obtained on an equality with cell efficiency of the reflective portion RA, thus both cell efficiency of the reflective portion RA and the transmissive portion TA can be maximized.

However, the reflective liquid crystal display devices of FIGs. 1 and 2 still have problems of reduction of color property in a transmissive mode operation. In other words, while reflected light passes through the color filter layer totally twice, i.e., before incidence and after reflection in the reflective plate, light from the backlight unit passes the color filter layer only once in the transmissive mode operation. Accordingly, there is a disadvantage that difference of color property in the reflective mode and the transmissive mode is generated. Also, a point that reflection efficiency is not maximized due to the flat reflective plate may be referred to as a disadvantage.

Recently, to overcome the above problems, a transflective liquid crystal display device has been suggested that has a through hole constitution of forming a hole in the color filter layer to adjust color property of the reflective portion and a reflective plate of an uneven structure.

As explained with reference to FIG. 3, as shown, in the transflective liquid crystal display device having a through hole TH in the color filter layer 80a, 80b and 80c and a reflective plate 41 of an uneven structure maximizing reflection efficiency, by forming a color filter layer 80a, 80b and 80c of a thickness suited to color property in the transmissive mode

operation and the through hole TH where a color filter resin is not formed in the color filter layer 80a, 80b and 80c to adjust color property and improve brightness, size and area of the through hole TH is adjusted, and thus brightness and color property can be controlled. Also, by forming the through hole TH in the color filter layer corresponding to the reflective portion RA, color property when passing through the color filter layer 80a, 80b and 80c twice is equalized with the transmissive mode, and at the same time, efficiency of light passing through the through hole TH where a color filter resin is not formed increases, thus brightness can be improved. Also, by disposing the reflective plate 41 of an uneven structure at a lower portion, reflection efficiency can be further improved.

However, as shown in FIG. 3, in the liquid crystal display device having the through hole TH in the color filter layer 80a, 80b and 80c, the dual cell gap that cell gaps d_3 and d_4 of the reflective portion RA and the transmissive portion TA are different, and the reflective plate 41 of an uneven structure increasing reflection efficiency, both a step (d_3-d_4) of the reflective portion RA and the transmissive portion TA for the dual cell gap and the reflective plate 41 of an uneven structure increasing reflection efficiency are formed on the array substrate 1. In a case of forming the unevenness 32 in the reflective portion RA increasing reflection efficiency, it is difficult to set optimized values of the step (d_3-d_4) of the reflective portion RA and the transmissive portion TA by etching the first passivation layer 31a and 31b and a profile of the unevenness 32 at once, and if size of the through hole TH formed in the color filter layer 80a, 80b and 80c on the color filter substrate 70 corresponding to the array substrate 1 is changed, an established process condition become wrong. Accordingly, there is difficulty for design and progress of process and there is a disadvantage that drawback increases in progress of process.

[TECHNICAL SUBJECT OF INVENTION]

As the present invention is suggested to resolve the problems of the prior art as explained above, an object of the present invention is to provide a transflective liquid crystal display device that has an uneven structure for optimizing reflection efficiency of a reflective portion, a dual cell gap and a through hole in a color filter layer and thus has excellent cell efficiency and color property.

Also, another object of the present invention is to provide a transflective liquid crystal display device increasing process stability by distributing difficulty on progress of process that is generated because processes of forming a dual cell gap, an unevenness of a reflective portion and the like are concentrated to an array substrate in a fabrication of the above-explained transflective liquid crystal display device.

[CONSTRUCTION AND OPERATION OF INVENTION]

To achieve the above objects, a transflective liquid crystal display device according to an embodiment of the present invention includes a lower substrate including a pixel defined by cross of a gate line extended along a horizontal direction and a data line extended along a vertical direction on a transparent substrate and having a reflective portion and a transmissive portion; a thin film transistor formed at a crossing point of the two lines; a first passivation layer covering the thin film transistor, formed on an entire surface of the substrate and having an uneven structure in the reflective portion; a reflective plate of an uneven structure formed on the first passivation layer of an uneven structre; a second passivation layer formed on the reflective plate of an uneven structure; and a pixel electrode formed on the second passivation layer and contacting a drain electrode; an upper substrarte including: red, green and blue color filter layers formed on an inner surface of a transparent substrate facing the pixel electrode of

the lower substrate and spaced apart at a regular interval and having a through hole corresponding to the reflective portion of each pixel on the upper substrate; an overcoat layer formed in the reflective portion below the red, green and blue color filter layers; and a common electrode formed below the overcoat layer; and a liquid crystal layer intervened between the pixel electrode of the lower substrate and the common electrode of the upper substrate.

At this time, the first passivation layer consists of a first organic film and a second organic film.

Also, an inorganic insulating film made of an inorganic insulating material between the first passivation layer and the reflective plate of an uneven structure can be further included.

A transflective liquid crystal display device according to another embodiment of the present invention includes a lower substrate including: a pixel defined by cross of a gate line extended along a horizontal direction and a data line extended along a vertical direction on a transparent substrate and having a reflective portion and a transmissive portion; a thin film transistor formed at a crossing point of the two lines; a passivation layer covering the thin film transistor, formed on an entire surface of the substrate and having an uneven structure in the reflective portion; a pixel electrode of an uneven structure formed on the passivation layer of an uneven structre and contacting a drain electrode; and a reflective plate of an uneven structure formed in the reflective portion on the pixel electrode; an upper substrarte including: red, green and blue color filter layers formed on an inner surface of a transparent substrate facing the pixel electrode of the lower substrate and spaced apart at a regular interval and having a through hole corresponding to the reflective portion of each pixel on the upper substrate; an overcoat layer formed in the reflective portion below the red, green and blue

color filter layers; and a common electrode formed below the overcoat layer; and a liquid crystal layer intervened between the pixel electrode of the lower substrate and the common electrode of the upper substrate.

At this time, the passivation layer consists of a first organic film and a second organic film.

Also, in the above two embodiments, the upper substrate can further include a black matrix between the transparent substrate and the red, green and blue color filter layers, and a thickness of the overcoat layer is the same as a thickness of the liquid crystal layer between the common electrode and the pixel electrode.

Also, it is characteristic that a thickness of the transmissive portion of the liquid crystal layer is double a thickness of the reflective portion of the liquid crystal layer.

A method of fabricating an array substrate for a transflective liquid crystal display device according to an embodiment of the present invention includes defining a pixel formed by cross of a gate line and a data line on a transparent substrate, and at the same time, defining a transmissive portion and a reflective portion on the pixel; forming a thin film transistor consisting of a gate electrode, an active layer, an ohmic contact layer, and source and drain electrodes on the defined pixel; forming a first passivation layer on an entire surface of the substrate over the thin film transistor and having an unevenness in the reflective portion and no step on the reflective portion and the transmissive portion except for the unevenness; forming a reflective plate of a uneven structure in the reflective portion on the first passivation layer; forming a second passivation layer on the reflective plate of an uneven structure; exposing the drain electrode of the thin film transistor by etching the second passivation layer and the first passivation layer; and forming a pixel electrode on the second passivation layer and contacting the drain electrode.

At this time, forming an inorganic insulating film between the first passivation layer and the reflective plate can be further included.

Also, the first passivation layer is one of benzocyclobutene (BCB) and photo-acryl of an organic insulating material, and the second passivation layer is one of one of silicon nitride (SiNx) and silicon oxide (SiO_2) of an inorganic insulating material or one of benzocyclobutene (BCB) and photo-acryl of an organic insulating material.

Another method of fabricating an array substrate for a transflective liquid crystal display device according to an embodiment of the present invention includes defining a pixel formed by cross of a gate line and a data line on a transparent substrate, and at the same time, defining a transmissive portion and a reflective portion on the pixel; forming a thin film transistor consisting of a gate electrode, an active layer, an ohmic contact layer, and source and drain electrodes on the defined pixel; forming a passivation layer on an entire surface of the substrate over the thin film transistor and having an unevenness in the reflective portion and no step on the reflective portion and the transmissive portion except for the unevenness; forming a drain contact hole exposing the drain electrode by etching the passivation layer; forming a pixel electrode contacting the drain electrode on the passivation layer where the drain contact hole is formed and having an unevenness in the reflective portion; and forming a reflective plate having an unevenness in the reflective portion on the pixel electrode.

At this time, in the fabrication method of the array substrate according to the two embodiments of the present invention, the reflective plate of an uneven structure is selected from aluminum (Al) or aluminum alloy having excellent reflectance.

A method of fabricating a color filter substrate for a transflective liquid crystal display device according to an embodiment of the present invention includes defining a region corresponding to a pixel and a transmissive portion and a reflective portion in the

region on a transparent substrate; (a) coating a red color filter resin on the substrate where the transmissive portion and the reflective portion are defined; (b) forming a red color filter layer having a plurality of through holes in the reflective portion by patterning the red color filter resin; forming green and blue color filter layers having a plurality of through holes in the reflective portion by repeating the steps (a) and (b); forming an overcoat layer in the reflective portion by coating and patterning a material which can be light-patterned and has excellent transmittance on the red, green and blue color filter layers; and forming a common electrode on the overcoat layer and the exposed color filter layer of the transmissive portion.

At this time, the overcoat layer is selected from negative type of photo-acryl series which can be light-patterned and has good transmittance.

Also, the overcoat layer has a thickness of a cell gap of the reflective portion that is a thickness of a liquid crystal layer of the reflective portion when attaching the color filter substrate and the array substrate with the liquid crystal layer intervened therebetween.

Hereinafter, embodiments of the present invention are explained in detail with reference to the accompanying drawings.

<First embodiment>

FIG. 4 is a plan view of a part of a transflective liquid crystal display device according to a first embodiment of the present invention.

A plurality of gate lines 103 are spaced apart at a regular interval and extended along a horizontal direction, a plurality of data lines 120 are extended along a vertical direction and cross the gate lines 103 to define pixel regions SP, and a thin film transistor Tr as a switching element is formed at a crossing point. Red, green and blue color filter layers are sequentially formed repeatedly in respective pixel regions SP formed by cross of the two lines. The pixel

SP where the red, green and blue color filters are formed includes a transmissive portion TA at a center of the pixel SP and a reflective portion RA at a region except for the transmissive portion, and a through hole TH where each color resin is removed is formed in the reflective portion RA.

Next, an inner structure of the liquid crystal display device is explained.

FIG. 5 is a cross-sectional view cutting the transflective liquid crystal display device of FIG. 4 along a line A-A.

As shown, the liquid crystal display device includes an array substrate 100 forming a lower substrate, a color filter substrate 170 forming an upper substrate and a liquid crystal layer 160 between the two substrates.

Firstly, with the array substrate 100 explained, a gate line (not shown) is formed on a transparent substrate 101 with a gate electrode 106 of a metallic material included, and a gate insulating film 110 of one of silicon oxide (SiO_2) and silicon nitride (SiNx) of an inorganic material on the gate line is formed on an entire surface of the substrate 101. An active layer 113 corresponding to the gate electrode 106 by the pixel SP is formed by depositing amorphous silicon, an ohmic contact layer 116a and 116b doped by impurity is formed on the active layer with the gate electrode 106 therebetween, and source and drain electrodes 123 and 126 of a metallic material are formed on the ohmic contact layer 116a and 116b. The gate electrode 106, a semiconductor layer of the active layer 113 and the ohmic contact layer 116a and 116b, and the source and the drain electrodes 123 and 126 constitute a thin film transistor Tr of a switching element.

Also, a data line 120 of the same material as the source and drain electrodes 123 and 126 is formed on the gate insulating film 110. The source electrode 123 and the data line 120 are connected to each other.

Next, a first passivation layer 130 of an organic material of benzocyclobutene (BCB) and the like are formed on the source and drain electrodes 123 and 126 and the data line 120, and at this time, the first passivation layer 130 has a double structure of a first organic film 130a for forming an organic film seed 132 of a convex structure and a second organic film 130b covering the organic film seed 132 of a convex structure and the first organic film 130a. At this time, the second organic film 130b has an uneven shape that a surface thereof is concave and convex in the reflective portion region RA due to the convex organic film seed 132 on the first organic film 130a below the second organic film.

Next, a reflective plate 140 of a metallic material is formed with concave and convex shape according to the below uneven shape on the first passivation layer 130 of an uneven shape, which is concave and convex, in the reflective portion RA. A second passivation layer 145 of one of silicon oxide (SiO_2) and silicon nitride (SiNx) of an inorganic material is formed on the reflective plate 140 of an uneven shape of the reflective portion RA and the first passivation layer 130 of the transmissive portion TA.

Next, the first passivation layer 130, the reflective plate 140 and the second passivation layer 145 over the drain electrode 126 of the thin film transistor Tr as a switching element are removed to form a drain contact hole 155, and a transparent electrode 150 deposited with one of indium-tin-oxide (ITO) and indium-zinc-oxide (IZO) of a transparent conductive material by the pixel SP is formed on the second passivation layer 145. The transparent electrode 150 contacts the drain electrode 126 through the drain contact hole 155.

Next, the color filter substrate 170 of the upper substrate is explained.

A black matrix 175 of a metallic material or a resin material is formed on a transparent substrate 171 corresponding to the gate line (not shown) and the data line 120 on the lower array substrate 101, and red, green and blue color filters 180a, 180b and 180c are formed

below the black matrix corresponding to respective pixels SP. Parts of color filter resins of the color filter layers 180a, 180b and 180c corresponding to the reflective portion RA are removed to form a through hole 182, and an overcoat layer 185 of a transparent material having a high transmittance is formed below the color filter layers 180a, 180b and 180c. The overcoat layer 185 is formed only in the reflective portion RA, but is not formed in the transmissive portion TA. Also, the overcoat layer 185 fills the through hole TH of the reflective portion region RA. At this time, by adjusting a height of the overcoat layer 185 of the reflective portion RA, a cell gap (a thickness of the liquid crystal layer, d_6) of the transmissive portion TA become double a cell gap d_5 of the reflective portion region RA.

Next, a common electrode 190 is formed below the overcoat layer 185.

<Second embodiment>

Since a color filter substrate of an upper substrate of a transflective liquid crystal display device according to a second embodiment of the present invention is the same as that of the first embodiment and a part of a structure of an array substrate 200 of a lower substrate is changed, explanations to the same parts as the first embodiment are omitted.

As FIG. 6 is a cross-sectional view of a transflective liquid crystal display device according to a second embodiment of the present invention, it is a cross-sectional view taken along a line A-A of FIG. 4.

As shown, in an array substrate 200 of a lower substrate, a thin film transistor Tr including a gate electrode 206, a gate insulating film 210, an active layer 213 and a ohmic contact layer 216a and 216b of a semiconductor layer, and source and drain electrodes 223 and 226 is formed in each pixel SP, and a passivation layer 230 covering the thin film

transistor Tr and having a uneven structure in a reflective portion RA is formed. A drain contact hole 255 exposing the drain electrode 226 is formed in the passivation layer 230.

Next, a pixel electrode 250 of one of indium-tin-oxide (ITO) and indium-zinc-oxide (IZO) of a transparent conductive material contacts the drain electrode 226 through the drain contact hole 255 and is formed in each pixel SP over the passivation layer 230 having an uneven structure in the reflective portion RA. The pixel electrode 250 has an uneven structure in the reflective portion RA due to the passivation layer 130 of an uneven structure.

Next, a reflective plate 240 of a metallic material having good reflectance, for example, aluminum (Al) or aluminum alloy is formed in the reflective portion RA. Since the reflective plate 240 directly contacts the pixel electrode 250, it forms a reflective electrode and has an uneven structure due to the pixel electrode of an uneven structure therebelow.

Since other structure including the color filter substrate is the same as that of the first embodiment, explanations are omitted.

The transflective liquid crystal display device having the above-explained structure (the liquid crystal display device shown in FIGs. 5 and 6) maximizes cell efficiency by making a difference between cell gaps ((d_5, d_7), (d_6, d_8)) of the reflective portion RA and the transmissive portion TA and insures color property in the reflective mode and the transmissive mode operations by forming the through hole TH in the color filter layers 180a, 180b and 180c, and 280a, 280b and 280c. Also, it maximizes reflection efficiency by forming the reflective plate 140 and 240 of an even structure in the reflective portion RA. It resolves a problem that it is difficult to set optimum values of the step and the profile of the unevenness according to formation of the uneven structure and the step portion on the prior art array substrate, by forming a step for forming a dual cell gap by adjusting a height of the overcoat layer 185 of the color filter substrate 170.

Next, fabrication methods of the array substrate and the color filter substrate of the transflective liquid crystal display device are explained.

< Fabrication method of the array substrate for the transflective liquid crystal display device of the first embodiment >

FIGs. 7a to 7f are cross-sectional views of a fabrication method of an array substrate for a transflective liquid crystal display device according to an embodiment of the present invention.

As shown in FIG. 7a, a gate electrode 106 and a gate line (not shown) are formed on a transparent substrate 101 by depositing one of metallic materials of chromium (Cr), aluminum (Al), copper (Cu) and the like to form a metallic layer, depositing a photoresist on the metallic layer, and performing a photolithographic process (hereinafter, referred to as a mask process) to pattern the metallic layer. At this time, when the metallic layer is formed of aluminum (Al), molybdenum (Mo) is deposited on aluminum and aluminum and molybdenum are patterned, thus a double-layered gate electrode can be formed. Then, a gate insulating film 110 is formed by depositing one of silicon nitride (SiNx) and silicon oxide (SiO_2) on the gate line (not shown) including the gate electrode 106.

Next, as shown in FIG. 7b, an active layer 113 is formed by deposing amorphous silicon (a-Si) on the gate insulating film 110 corresponding to the gate electrode 106 and a photoresist thereon and performing a mask process, and an ohmic contact layer 116A and 116B of amorphous silicon including impurity is formed on the active layer 113 by injecting impurity into the active layer 113. Then, Source and drain electrodes 123 and 126 spaced apart at a regular interval with the gate electrode 106 therebetween are formed on the ohmic contact layer 116a and 116b by depositing and patterning one of metallic materials of

chromium (Cr), molybdenum (Mo), aluminum (Al) and the like, and at the same, a data line 120 crossing the gate line (not shown) to define a pixel SP is formed. At this time, the source and drain electrode 123 and 126 and the data line 120 may be formed of a double layer of aluminum/chromium (Al/Cr) and aluminum/molybdenum (Al/Mo). Then, the ohmic contact layer (not shown) exposed through a spaced-apart region between the source and drain electrodes 123 and 126 is removed and the active layer 113 therebelow is exposed to form a channel. Since the source and drain electrodes 123 and 126 are used as a mask, a separate mask is not needed. The source and drain electrodes 123 and 126, the ohmic contact layer 116a and 116b, the active layer 113 and the gate electrode 106 constitute a thin film transistor Tr of a switching element.

Next, as shown in FIG. 7c, a first organic film 130a is formed on an entire surface of the substrate 101 by coating a colorless transparent organic material of benzocyclobutene (BCB), photo-acryl and the like on the source and drain electrodes 123 and 126 and the data line 120. At this time, processes are different according to kind of the organic materials, when benzocyclobutene (BCB) is used, a photoresist is coated on the first organic film, patterned, and thus an organic film seed 132 for forming the unevenness is formed with the patterned photoresist used as a mask, and when photo-acryl is used for forming the first organic film, since the photo-acryl is a photosensitive resin, the organic film seed is formed by exposing and etching without the photoresist. In this embodiment, a method of forming the unevenness using the photo-acryl is explained.

Firstly, a mask process of exposing, developing and etching the first organic film 130a of the photo-acryl is performed to form the organic film pattern 131 of a saw tooth shape having regular interval and size in the reflective portion RA. At this time, a slant angle of the organic film pattern 131 may be adjusted by adjusting interval and overlap between patterns

of a mask. As this organic material, a material a portion of which exposed on light is removed may be used, or a material a portion of which not exposed on light is removed may be used.

Next, as shown in FIG. 7d, the organic film seed 132 of a convex shape is formed by thermal-treating the organic film pattern 131 of a saw tooth shape. The organic film pattern 131 of a saw tooth shape is melted and flow by thermal treatment, then solidified to form the organic film seed 132 having a slant angle and a gentle winding.

Next, as shown in FIG. 7e, a second organic film 130b is formed by coating and baking photo-acryl on an entire surface of the first organic film 130a where the organic film seed 132 of a convex shape is formed. At this time, the second organic film 130b has a winding having a concave and a convex due to the organic film seed 132 of a convex shape on the first organic film 130a. The first and second organic films 130a and 130b constitute a first passivation layer 130.

Next, as shown in FIG. 7f, a reflective plate 140 of an uneven structure having concave and convex is formed by depositing one of aluminum (Al) and aluminum alloy of a metallic material having an excellent reflectance on an entire surface of the first passivation layer 131 and patterning it through a mask process. The reflective plate 140 of an uneven structure is formed only in the reflective portion region RA and not formed in the transmissive portion region TA. Also, it is not formed in a drain contact hole formation portion CA exposing the drain electrode 126. At this time, since a deposition of a metallic material is conventionally performed by a sputtering, if the reflective plate 180 is formed by depositing a metallic material directly on the organic film, an inside portion of a chamber of a sputtering apparatus may be contaminated and drawback may be generated, and thus an inorganic material may deposited on the first passivation layer 130 to form an inorganic insulating film (not shown), then a reflective plate 180 may be formed.

Next, as shown in FIG. 7g, a second passivation layer 145 is formed on the reflective layer 140 of an uneven structure by depositing one of silicon oxide (SiO_2) and silicon nitride (SiNx) of an inorganic material or coating one of benzocyclobutene (BCB) and photo-acryl of an organic material on an entire surface of the substrate 101. Then, a drain contact hole 155 is formed by removing the second and first passivation layers 145 and 130 over the drain electrode 126 with a dry etching process.

Next, a pixel electrode 150 divided by the pixel SP is formed by depositing and patterning one of indium-tin-oxide (ITO) and indium-zinc-oxide (IZO) of a transparent conductive material on the second passivation layer 145. At this time, the pixel electrode 150 contacts the drain electrode 126 through the drain contact hole 155.

< Fabrication method of the array substrate for the transflective liquid crystal display device of the second embodiment>

FIGs. 8a to 8e are cross-sectional views of a fabrication method of an array substrate for a transflective liquid crystal display device according to an embodiment of the present invention.

Since steps of fabricating a thin film transistor Tr is the same as those of fabricating the array substrate according to the first embodiment, explanations are omitted.

As shown in FIG. 8a, a thin film transistor Tr consisting of a gate electrode 206, an active layer 213, an ohmic contact layer 216a and 216b, and source and drain electrodes 223 and 226 is formed in each pixel SP. At this time, the gate insulating film 210 is formed on an entire surface of the substrate 201 over the gate electrode 206, and elements except for the gate electrode constituting the thin film transistor and a data line 220 crossing a gate line to define the pixel SP are formed.

Next, a first organic film 230a is formed on an entire surface of the substrate 201 by coating a colorless transparent organic material of benzocyclobutene (BCB), photo-acryl and the like on the thin film transistor Tr. At this time, since processes are different according to kind of the organic materials, in this embodiment, a method of forming the passivation layer 230 of an uneven structure with the first organic film 230a of benzocyclobutene (BCB) is explained.

Firstly, a photoresist is coated on the first organic film 230a to form a photoresist layer 231, a mask having a part transmitting light and a part shielding light spaced apart at a regular interval is disposed, and then a exposure process is performed. Next, the exposed photoresist layer 231 is developed to form photoresist patterns 232 spaced apart at a regular interval and of a convex shape in the reflective portion RA.

Next, as shown in FIG. 8b, a dry etching for the substrate 201 where the photoresist pattern 232 is formed is performed to transfer the photoresist pattern 232 to the first organic film 230a, and thus an organic film seed 233 having a regular interval and a slant angle is formed.

Next, as shown in FIG. 8c, a second organic film 230b is formed by depositing benzocyclobutene (BCB) on the organic film seed 233. The second organic film 230b has an uneven surface having concave and convex in the reflective portion RA due to the convex organic film seed 233, and the first and second organic films 230a and 230b constitute a passivation layer 230.

Next, as shown in FIG. 8d, a drain contact hole 255 exposing the drain electrode 226 is formed by etching the passivation layers 230, and then a pixel electrode 250 contacting the drain electrode 226 is formed by depositing one of indium-tin-oxide (ITO) and indium-zinc-oxide (IZO) of a transparent conductive material on the uneven passivation layer 230 where

the drain contact hole 255 is formed and patterning it with a mask process. The pixel electrode 250 has an uneven shape in the reflective portion RA due to the passivation layer 230 of an uneven structure.

Next, as shown in FIG. 8e, a reflective plate 240 of an uneven structure is formed in the reflective portion RA by depositing and patterning a metallic material having an excellent reflectance on the pixel electrode 250. Since the reflective plate 240 contacts the pixel electrode 250, it forms a reflective electrode.

Next, a fabrication method of the color filter substrate for the transflective liquid crystal display device according to an embodiment of the present invention is explained.

< Fabrication method of the color filter substrate according to the transflective liquid crystal display device of the first and second embodiments >

FIGs. 9a to 9d are cross-sectional views of a fabrication method of a color filter substrate for a transflective liquid crystal display device according to the present invention.

As shown in FIG. 9a, a black matrix 175 is formed by depositing a metallic material or coating a resin on a transparent substrate 171 and patterning it with a mask process. The black matrix 175 may be not formed when a liquid crystal display device has high resolution and high aperture ratio.

As shown in FIG. 9b, a red color filter layer 180a having a through hole TH in a reflective portion RA is formed by coating a red color resin on an entire surface of the substrate 171 and patterning it with a mask process. At this time, the number and size of the through hole TH are determined such that color property is optimized in the reflective mode and the transmissive mode operations.

Next, as shown in FIG. 9c, in the same manner as FIG. 9b, green and blue color filter layers 180b and 180c having the through hole TH in the reflective portion RA are sequentially formed. Even though not shown in the drawings, the red, green and blue color filters are repeatedly formed in the substrate 171 corresponding to respective pixels of the array substrate.

Next, as shown in FIG. 9d, an overcoat layer 185 is formed in the reflective portion RA by coating an overcoat material which can be light-patterned and has a high transmittance on the red, green and blue color filter layers 180a, 180b and 180c and patterning it with a mask process. At this time, the overcoat layer 185 of the transmissive portion TA is entirely removed to expose the color filter layer 180a, 180b and 180c, and the overcoat layer 185 of the reflective portion RA has a thickness of half a cell gap of the transmissive portion TA of the liquid crystal display device.

Next, a common electrode 190 is formed by depositing one of indium-tin-oxide (ITO) and indium-zinc-oxide (IZO) of a transparent conductive material on the overcoat layer 185 and the exposed color filter layer 180a, 180b and 180c.

A cell process consisting of an orientation process, a gap process and an inspection process are performed for the array substrate (FIGs. 7f and 8e) and the color filter substrate (FIG. 9d) as fabricated above, a liquid crystal layer is formed between the pixel electrode and the common electrode of the two substrates, and the liquid crystal display device having a dual cell gap of the transmissive portion and the reflective portion is fabricated.

[EFFECT OF INVENTION]

As explained above, when the transflective liquid crystal display device is fabricated using the array substrate and the color filter substrate according to the desirable embodiment of the present invention, there are characteristics as follows.

Since a reflective plate of an uneven structure is formed in a reflective portion region on an array substrate, reflection efficiency can be maximized in a reflection mode operation, and since a passivation layer of concave and convex structure for forming the reflective plate of an uneven structure is formed without a step of the reflective portion and the transmissive portion, process difficulty of optimization of a step and a profile of an unevenness is removed and thus process drawback can be reduced in a fabrication of an array substrate.

Also, since a step of the transmissive portion and the reflective portion is embodied using an overcoat layer on a color filter substrate, a dual cell gap is formed and thus cell efficiency can be maximized.

Also, since a through hole is formed on a color filter layer on a color filter substrate to adjust different color properties in reflective mode and transmissive mode operations, number and size of the through hole is adjusted, thus color property of the two modes can be insured and brightness of the reflective mode can increase.

[RANGE OF CLAIMS]

[CLAIM 1]

A transflective liquid crystal display device, comprising:

a lower substrate including:

a pixel defined by cross of a gate line extended along a horizontal direction and a data line extended along a vertical direction on a transparent substrate and having a reflective portion and a transmissive portion;

a thin film transistor formed at a crossing point of the two lines;

a first passivation layer covering the thin film transistor, formed on an entire surface of the substrate and having an uneven structure in the reflective portion;

a reflective plate of an uneven structure formed on the first passivation layer of an uneven structre;

a second passivation layer formed on the reflective plate of an uneven structure; and

a pixel electrode formed on the second passivation layer and contacting a drain electrode;

an upper substrarte including:

red, green and blue color filter layers formed on an inner surface of a transparent substrate facing the pixel electrode of the lower substrate and spaced apart

at a regular interval and having a through hole corresponding to the reflective portion of each pixel on the upper substrate;

an overcoat layer formed in the reflective portion below the red, green and blue color filter layers; and

a common electrode formed below the overcoat layer; and

a liquid crystal layer intervened between the pixel electrode of the lower substrate and the common electrode of the upper substrate.

[CLAIM 2]

A transflective liquid crystal display device, comprising:

a lower substrate including:

a pixel defined by cross of a gate line extended along a horizontal direction and a data line extended along a vertical direction on a transparent substrate and having a reflective portion and a transmissive portion;

a thin film transistor formed at a crossing point of the two lines;

a passivation layer covering the thin film transistor, formed on an entire surface of the substrate and having an uneven structure in the reflective portion;

a pixel electrode of an uneven structure formed on the passivation layer of an uneven structre and contacting a drain electrode; and

a reflective plate of an uneven structure formed in the reflective portion on the pixel electrode;

an upper substrarte including:

red, green and blue color filter layers formed on an inner surface of a transparent substrate facing the pixel electrode of the lower substrate and spaced apart at a regular interval and having a through hole corresponding to the reflective portion of each pixel on the upper substrate;

an overcoat layer formed in the reflective portion below the red, green and blue color filter layers; and

a common electrode formed below the overcoat layer; and

a liquid crystal layer intervened between the pixel electrode of the lower substrate and the common electrode of the upper substrate.

[CLAIM 3]

The device according to one of claims 1 and 2, wherein the upper substrate further includes a black matrix between the transparent substrate and the red, green and blue color filter layers.

[CLAIM 4]

The device according to one of claims 1 and 2, wherein a thickness of the overcoat layer is the same as a thickness of the liquid crystal layer between the common electrode and the pixel electrode.

[CLAIM 5]

The device according to one of claims 1 and 2, wherein a thickness of the transmissive portion of the liquid crystal layer is double a thickness of the reflective portion of the liquid crystal layer.

[CLAIM 6]

The device according to claim 1, wherein the first passivation layer consists of a first organic film and a second organic film.

[CLAIM 7]

The device according to claim 1, further comprising an inorganic insulating film made of an inorganic insulating material between the first passivation layer and the reflective plate of an uneven structure.

[CLAIM 8]

The device according to claim 2, wherein the passivation layer consists of a first organic film and a second organic film.

[CLAIM 9]

A method of fabricating an array substrate for a transflective liquid crystal display device, comprising:

defining a pixel formed by cross of a gate line and a data line on a transparent substrate, and at the same time, defining a transmissive portion and a reflective portion on the pixel;

forming a thin film transistor consisting of a gate electrode, an active layer, an ohmic contact layer, and source and drain electrodes on the defined pixel;

forming a first passivation layer on an entire surface of the substrate over the thin film transistor and having an unevenness in the reflective portion and no step on the reflective portion and the transmissive portion except for the unevenness;

forming a reflective plate of a uneven structure in the reflective portion on the first passivation layer;

forming a second passivation layer on the reflective plate of an uneven structure;

exposing the drain electrode of the thin film transistor by etching the second passivation layer and the first passivation layer; and

forming a pixel electrode on the second passivation layer and contacting the drain electrode.

[CLAIM 10]

A method of fabricating an array substrate for a transflective liquid crystal display device, comprising:

defining a pixel formed by cross of a gate line and a data line on a transparent substrate, and at the same time, defining a transmissive portion and a reflective portion on the pixel;

forming a thin film transistor consisting of a gate electrode, an active layer, an ohmic contact layer, and source and drain electrodes on the defined pixel;

forming a passivation layer on an entire surface of the substrate over the thin film transistor and having an unevenness in the reflective portion and no step on the reflective portion and the transmissive portion except for the unevenness;

forming a drain contact hole exposing the drain electrode by etching the passivation layer;

forming a pixel electrode contacting the drain electrode on the passivation layer where the drain contact hole is formed and having an unevenness in the reflective portion; and

forming a reflective plate having an unevenness in the reflective portion on the pixel electrode.

[CLAIM 11]

The method according to one of claims 9 and 10, wherein the reflective plate of an uneven structure is one of aluminum (Al) and aluminum alloy having excellent reflectance.

[CLAIM 12]

The method according to claim 9, further comprising forming an inorganic insulating film between the first passivation layer and the reflective plate.

[CLAIM 13]

The method according to claim 9, wherein the first passivation layer is one of benzocyclobutene (BCB) and photo-acryl of an organic insulating material.

[CLAIM 14]

The method according to claim 9, wherein the second passivation layer is one of one of silicon nitride (SiNx) and silicon oxide (SiO_2) of an inorganic insulating material.

[CLAIM 15]

The method according to claim 9, wherein the second passivation layer is one of benzocyclobutene (BCB) and photo-acryl of an organic insulating material.

[CLAIM 16]

A method of fabricating a color filter substrate for a transflective liquid crystal display device, comprising:

defining a region corresponding to a pixel and a transmissive portion and a reflective portion in the region on a transparent substrate;

(a) coating a red color filter resin on the substrate where the transmissive portion and the reflective portion are defined;

(b) forming a red color filter layer having a plurality of through holes in the reflective portion by patterning the red color filter resin;

forming green and blue color filter layers having a plurality of through holes in the reflective portion by repeating the steps (a) and (b);

forming an overcoat layer in the reflective portion by coating and patterning a material which can be light-patterned and has excellent transmittance on the red, green and blue color filter layers; and

forming a common electrode on the overcoat layer and the exposed color filter layer of the transmissive portion.

[CLAIM 17]

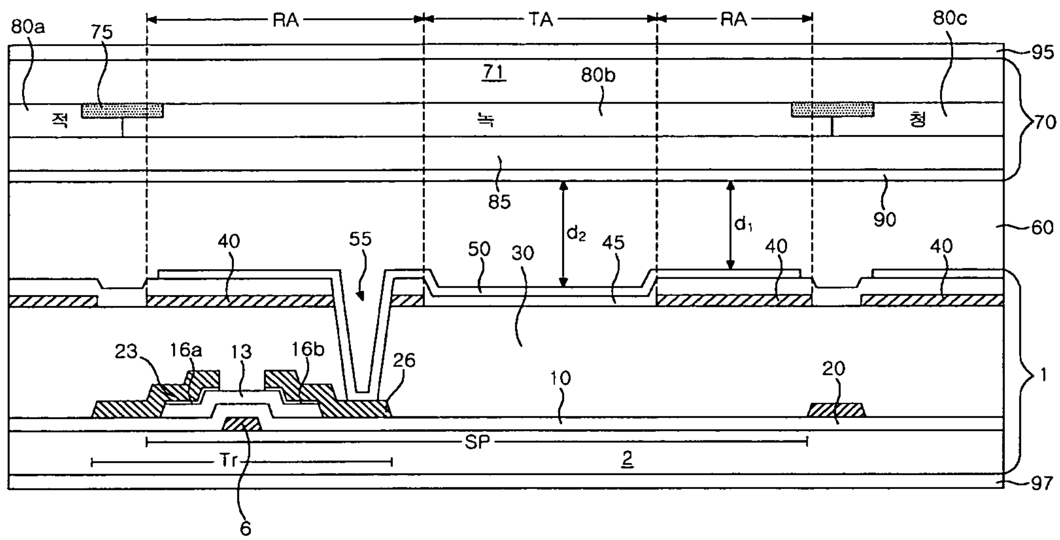
The method according to claim 16, wherein the overcoat layer is selected from negative type of photo-acryl series which can be light-patterned and has good transmittance.

[CLAIM 18]

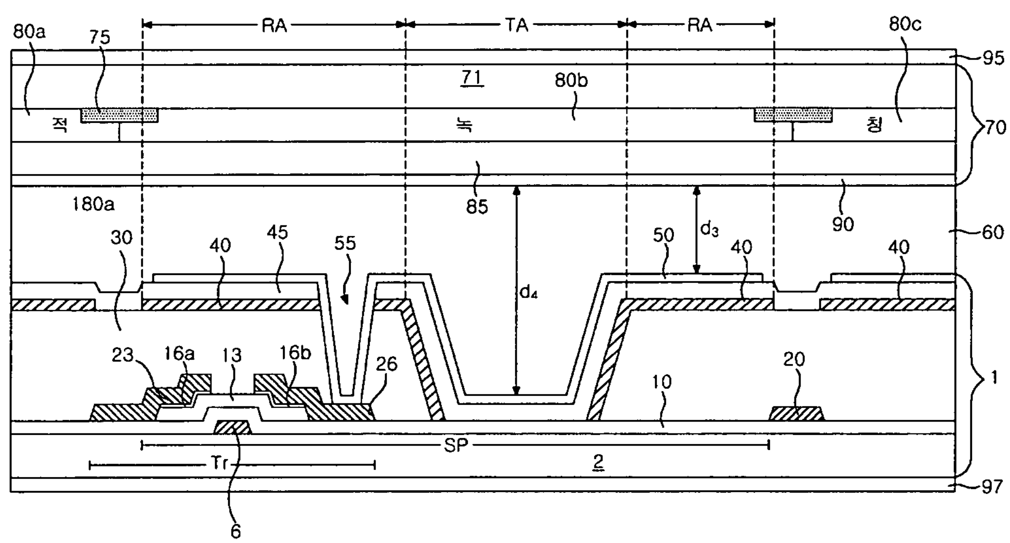
The method according to claim 16, wherein the overcoat layer has a thickness of a cell gap of the reflective portion that is a thickness of a liquid crystal layer of the reflective portion when attaching the color filter substrate and the array substrate with the liquid crystal layer intervened therebetween.

[DRAWINGS]

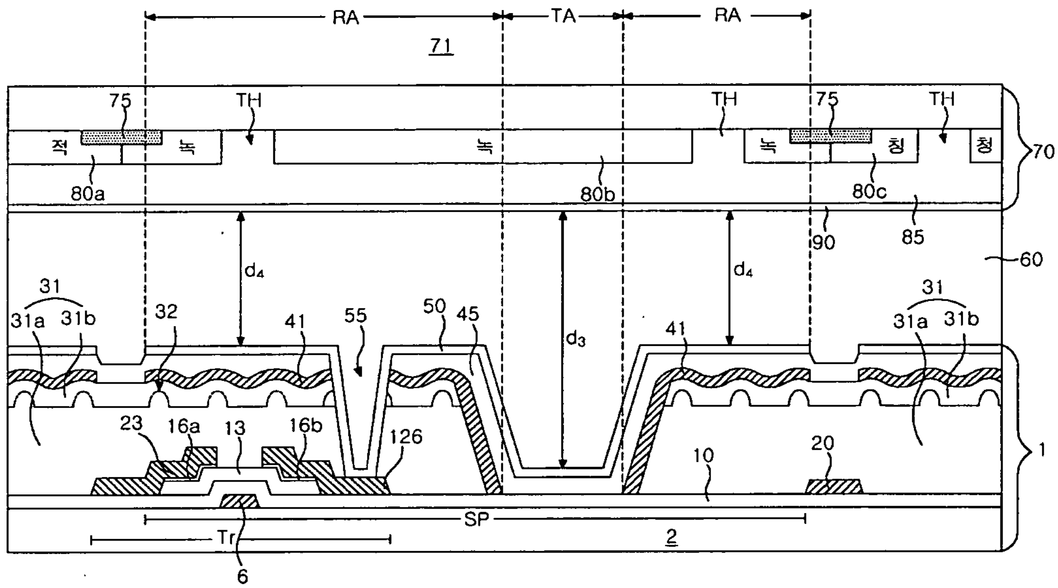
【FIG. 1】



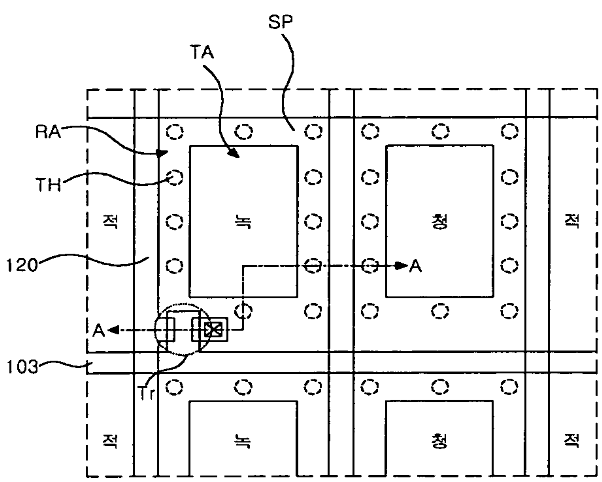
【FIG. 2】



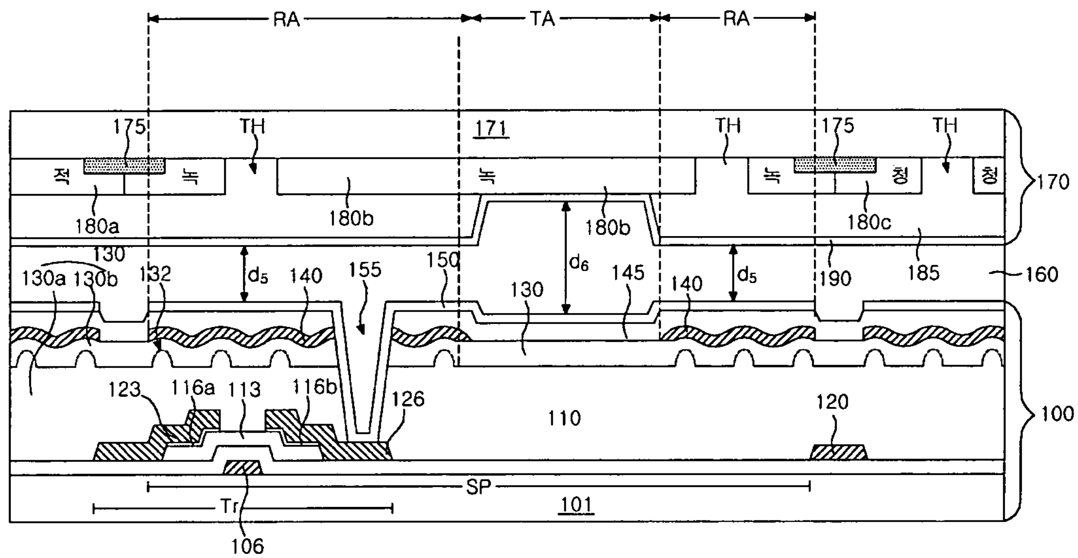
【FIG. 3】


RA
TA
RA
71
75
TH
TH
75
TH
적
녹
녹
녹
청
청
70
80a
80b
80c
90
85
60
d₄
d₄
d₃
31
31a
31b
32
41
55
50
45
41
31
31a
31b
23
16a
13
16b
126
10
20
1
SP
Tr
2
6

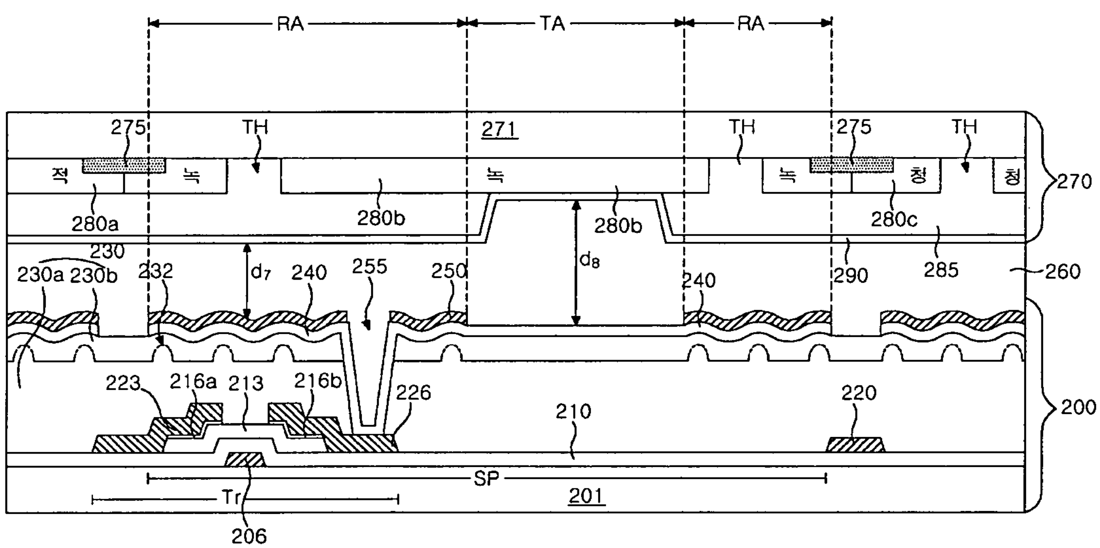
【FIG. 4】


SP
TA
RA
TH
120
103
Tr
A
A
적
녹
청
적
적
녹
청
적

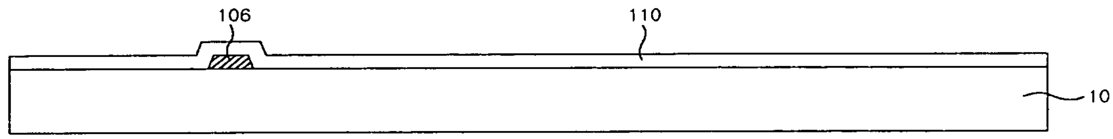
【FIG. 5】



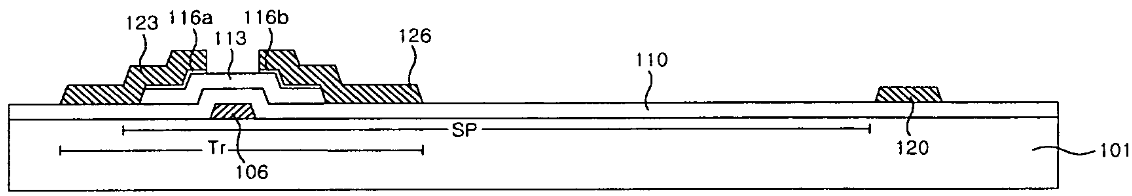
【FIG. 6】



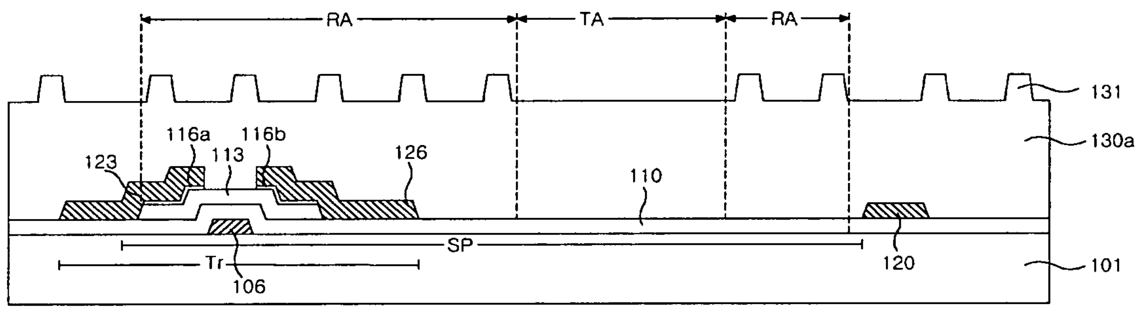
【FIG. 7a】



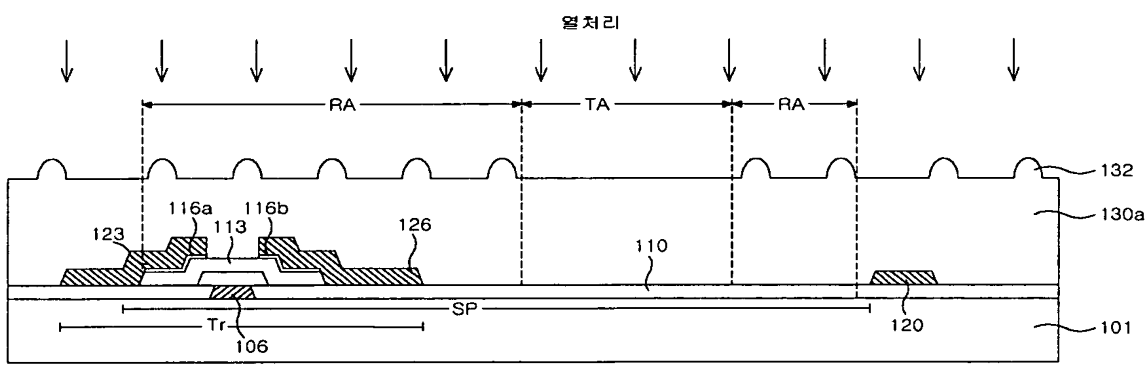
【FIG. 7b】



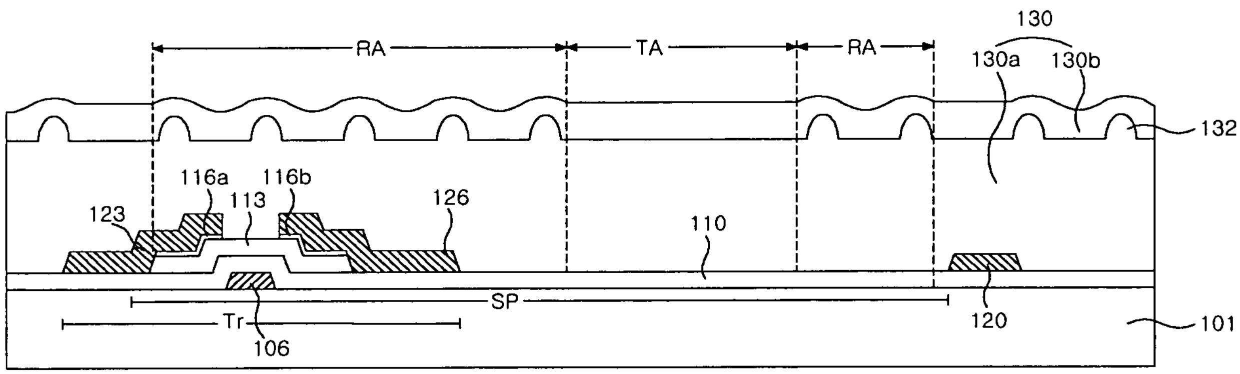
【FIG. 7c】



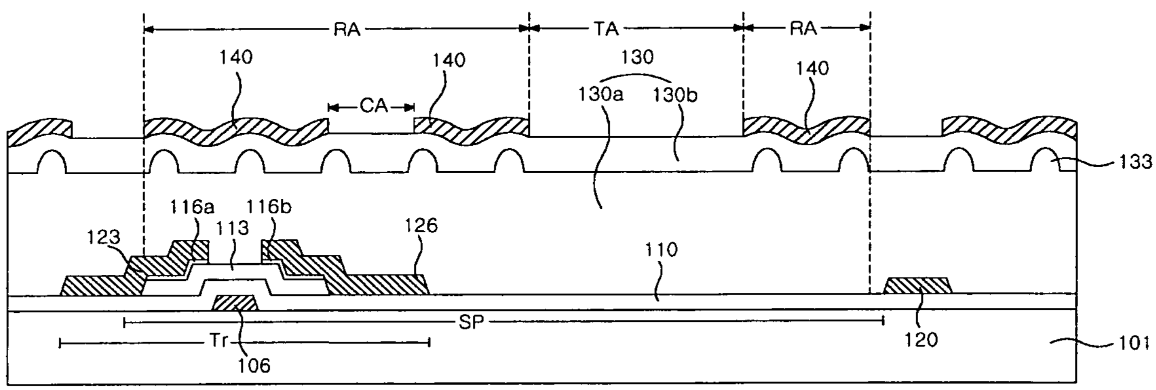
【FIG. 7d】



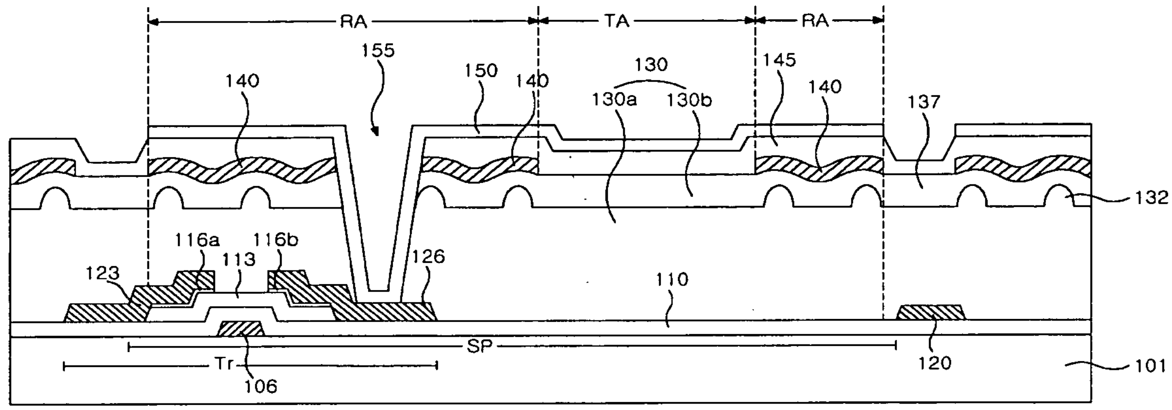
【FIG. 7e】



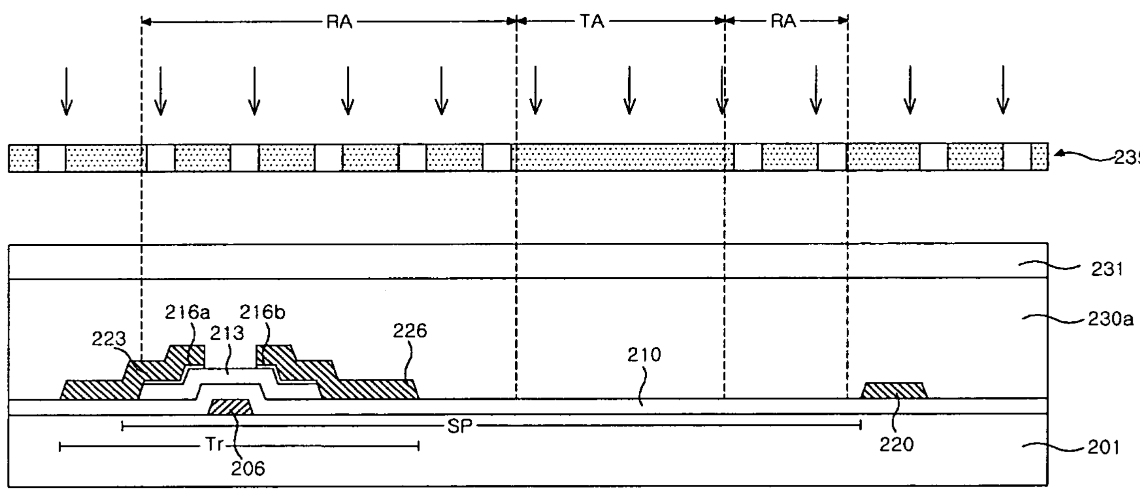
【FIG. 7f】



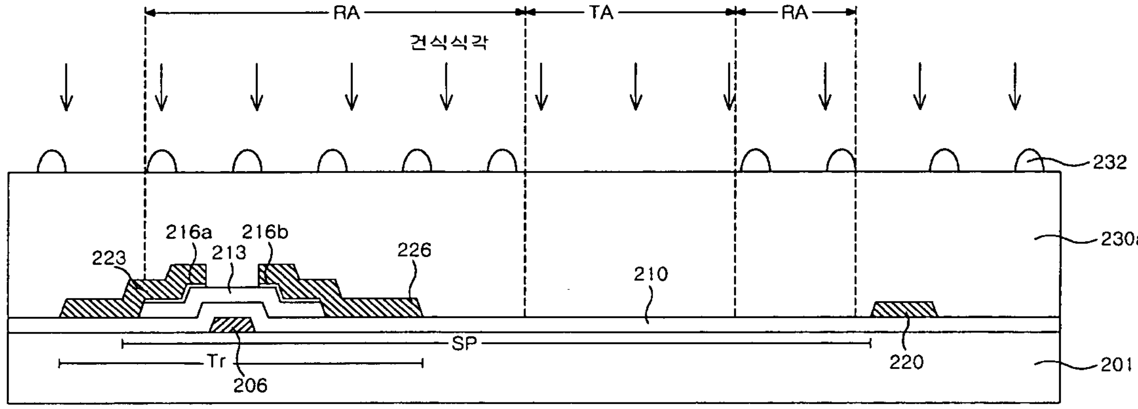
【FIG. 7g】


RA
TA
RA
155
150
140
130
130a
130b
145
140
137
140
132
116a
116b
113
123
126
110
SP
Tr
106
120
101

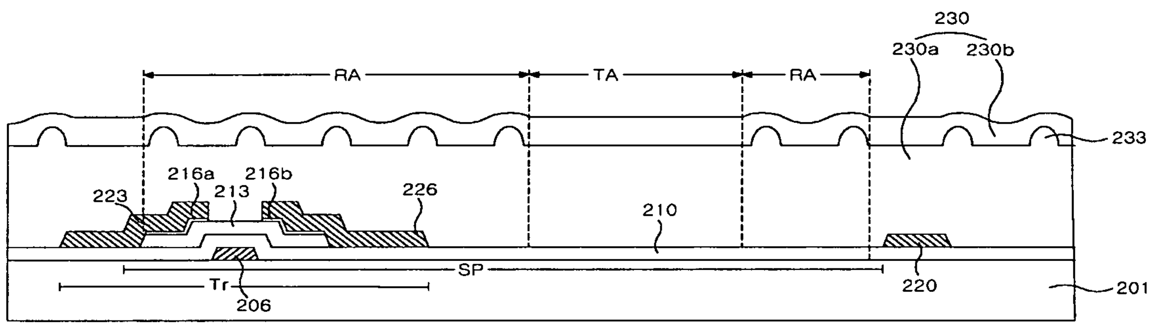
【FIG. 8a】


RA
TA
RA
235
231
230a
216a
216b
213
223
226
210
SP
Tr
206
220
201

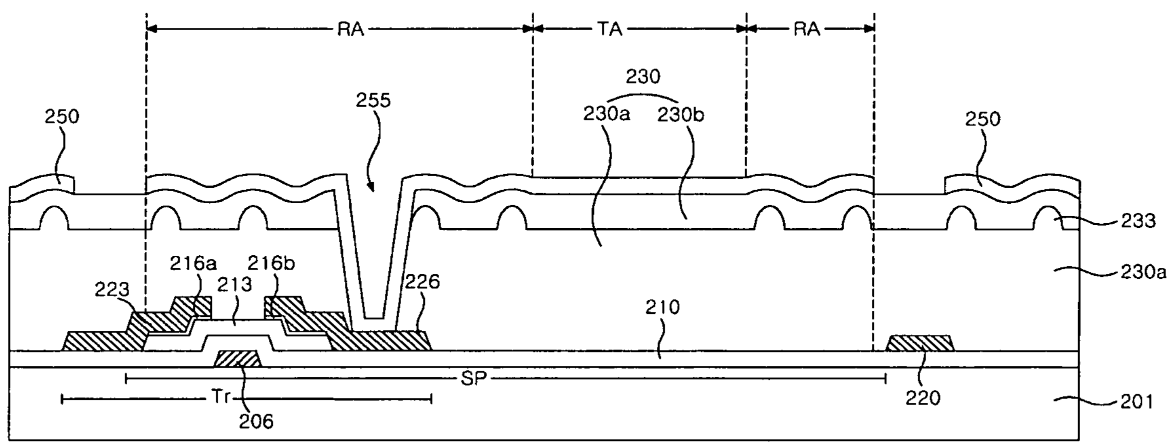
【FIG. 8b】



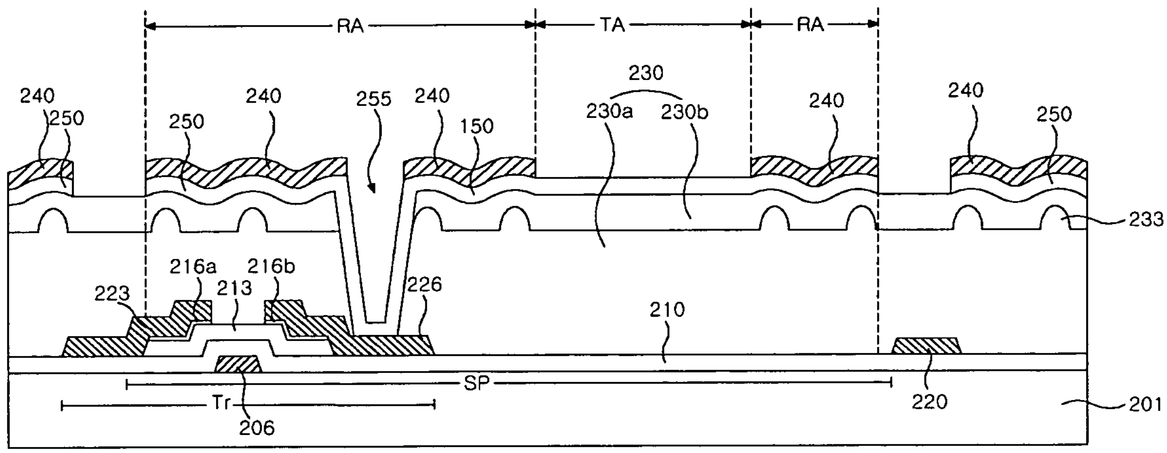
【FIG. 8c】



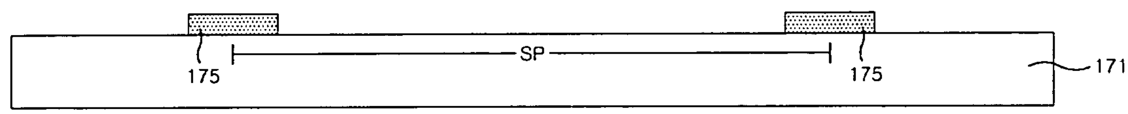
【FIG. 8d】



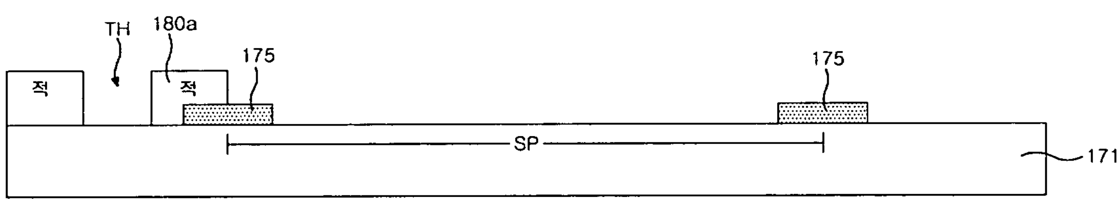
【FIG. 8e】



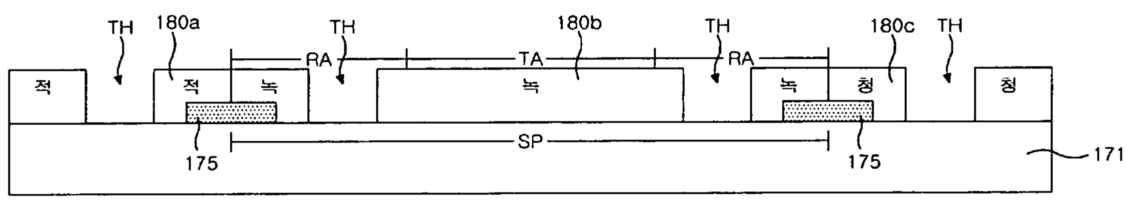
【FIG. 9a】



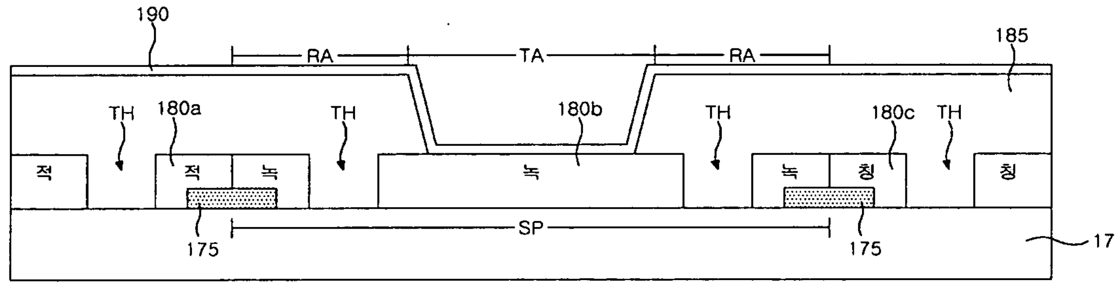
【FIG. 9b】



【FIG. 9c】



【FIG. 9d】



190
RA
TA
RA
185
TH
180a
TH
180b
TH
180c
TH
적
적
녹
녹
녹
청
청
SP
175
175
171